STUDY OF INFLUENCE THE MUSEUM MODEL ON HIGH SCHOOL STUDENTS' CHEMISTRY LEARNING

Ana C. Steola[1] , Franciani C. Sentanin[1*], Patrícia R. da Silva[2], Ana C. Kasseboehmer[1]

1- São Carlos Chemistry Institute, University of São Paulo, São Carlos - SP, Brazil

2- Public School André Donatoni, Ibaté – SP, Brazil

** fransentanin@usp.br*

ABSTRACT

This paper presents the results of a study with high school students from a public school located located in the interior of São Paulo-SP. The chosen subject was oxirreduction. An museal interactive chemistry model was used, which shows the degradation of dyes present in the water due to the disposal of the textile industry through oxidative processes, and an experiment that demonstrates the corrosion of metals. The chemistry teacher introduced the concept in a lecture and later was made a visit of students to the Museum of Science Mario Tolentino, where is the model, and where the experiment was also performed. The introductory class, the model visit and the experiment took place in order to obey a previously established conceptual organization, favoring the processes of progressive differentiation and integrative reconciliation based on Ausubel's theory of learning. Tests were applied in the introductory class, after the visit to the model and also after the experiment for subsequent comparison of results, which were used to verify if the use of the model and the experiment promoted significant learning in relation to the proposed theme.

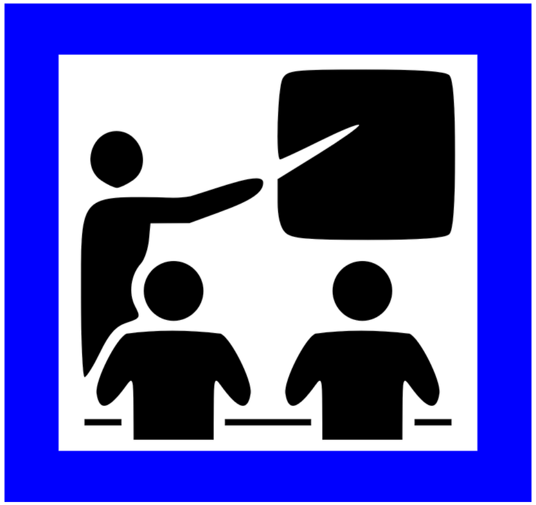
Keywords Interactive model, meaningful learning, education in non-formal environments.

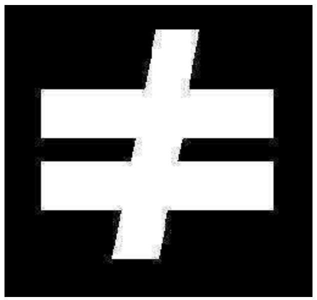
INTRODUCTION

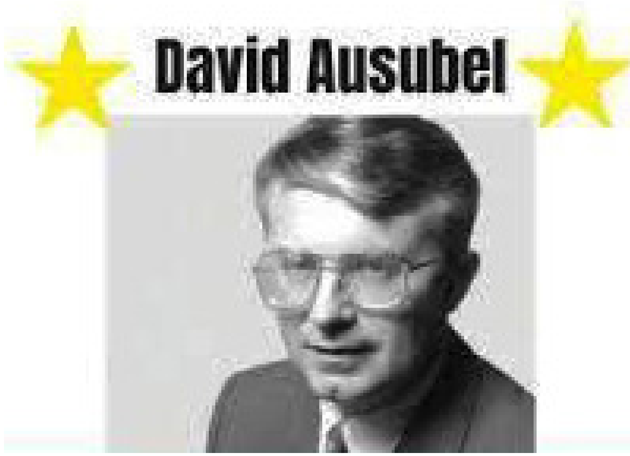
Brazilian education is far below world standards and its quality continues to show an insufficient evolution. This fact impairs the teaching of science, since it is noted that besides the lack of teachers of basic subjects (Physics, Chemistry, Biology), there is a lack of spaces available for practical classes (laboratories), materials and technicians, which limits teachers' performance. Nowadays the school is no longer characterized as the only learning space or the teacher as the only source of knowledge.

Nowadays the school is no longer characterized as the only learning space or the teacher as the only source of knowledge. Today there are various sources of information, such as the World Wide Web, museums, parks, and spaces for science and culture. However, even with all these facilities, the traditional pedagogical culture is still present in the daily life of schools.

This kind of classes difficult the learning of chemical concepts, because these concepts have a high degree of abstraction and complexity, so students feel bored and uninterested in their study. This problem is not consistent with the theory of meaningful learning, created by Ausubel [1], who argues that "new knowledge" must be presented to the student so he can make relationships with his previous experience and / or knowledge, producing meaningful learning.

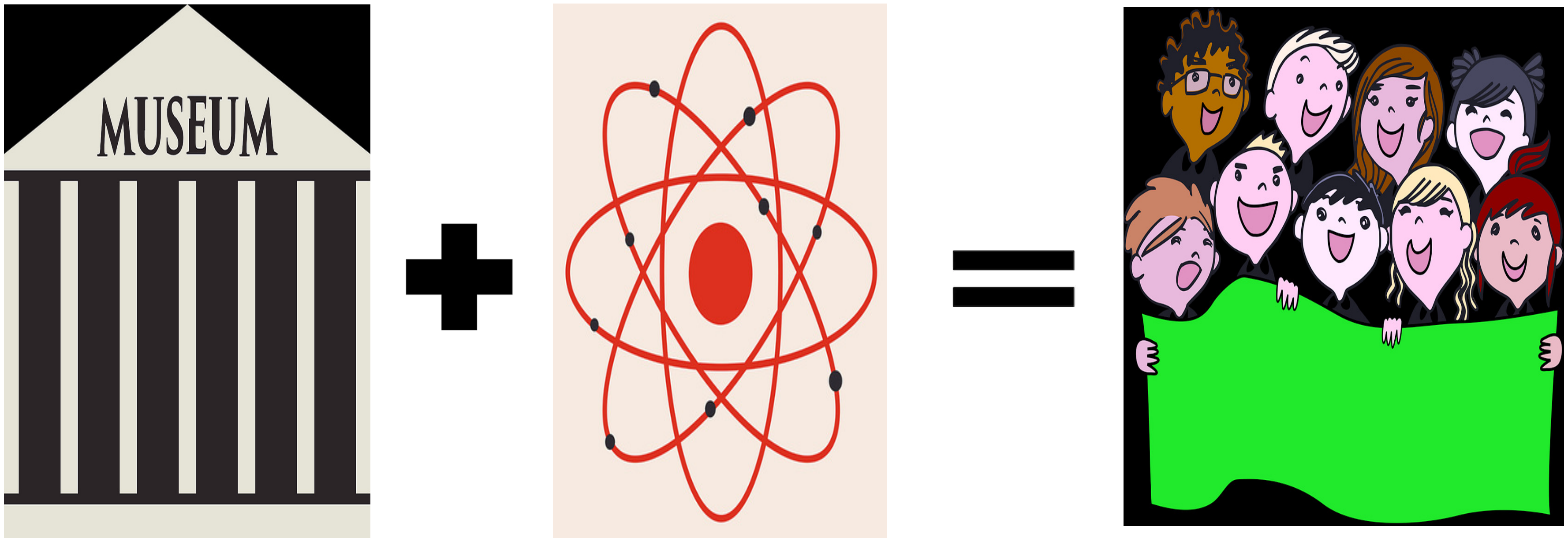






According to this theory, teaching means creating situations that favor meaningful learning. There are several alternatives for verifying the occurrence of meaningful learning, such as sequentially linked learning tasks, supporting later stages of activity. In order to work chemistry significantly, the teacher must make the planning of the classes in such a way as to verify the students' previous knowledge and also develop activities with different teaching strategies and pedagogical resources. One feature that can be used to link the student's "new and previous knowledge" is the use of visitations in non-formal learning spaces, such as museum exhibitions that make use of interactive models [2].

Nowadays, the goal of museums is to promote an approximation and understanding of the public that visits them with science and technology, through activities, educational experiences that are practical and focused on interdisciplinarity and playfulness, promoting the interaction of the public with the object exposed [3].



However, according to Steola and Kasseboehmer [4], Chemistry activities in Brazilian museums are still scarce, mainly due to safety issues, cost of design and maintenance of interactive modules, waste management, need for visitor monitoring as well as limitations on the physical space of the institutions.

IQSC

NARST

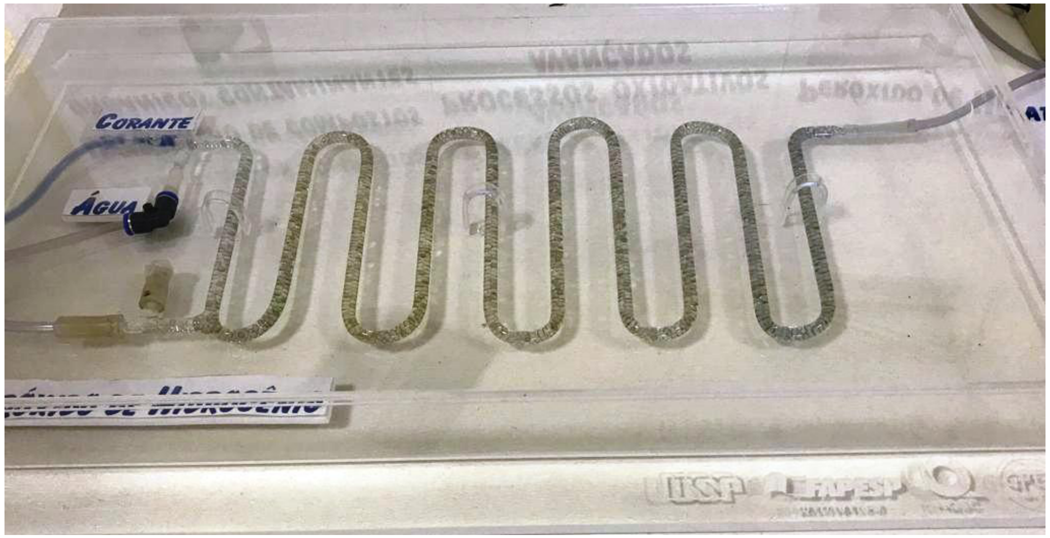
A global organization for improving science education through research

LINECIN

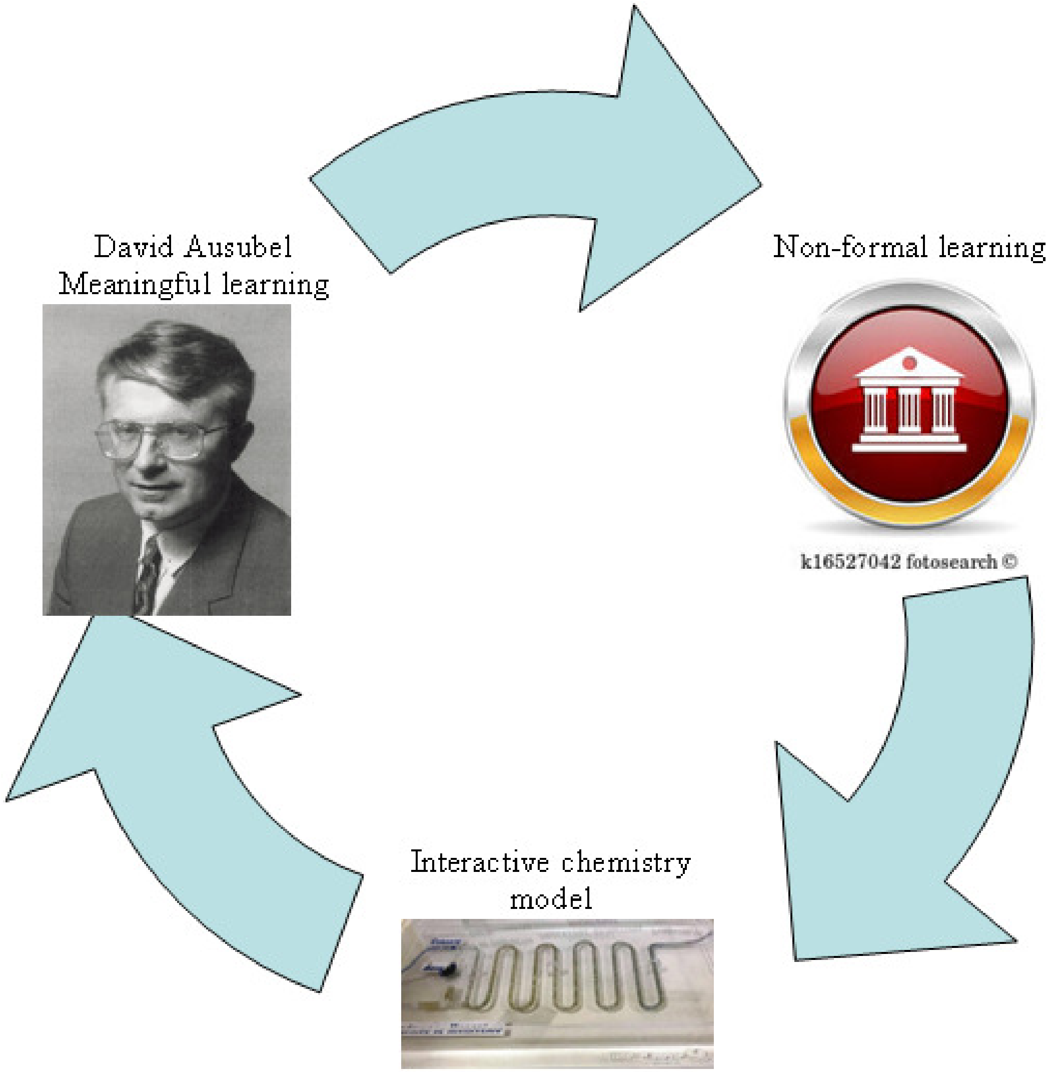
GPEA

IQSC / USP

In this context, the use of interactive chemistry model in these non-formal education spaces is innovative, since it can solve all these questions, as shown by Steola [5]. In this research, a museum model was built by Professor Marcos Lanza PhD a researcher from University of São Paulo, Brazil on the field of Environmental Chemistry who intends to publicize his research to the population. This model is a closed reaction system that simulates the degradation of the Reactive Blue 19 dye using hydrogen peroxide and it do not prejudice the public, is attractive and can be put into exposure without the need for a monitor to control, being easy to understand and manipulate.

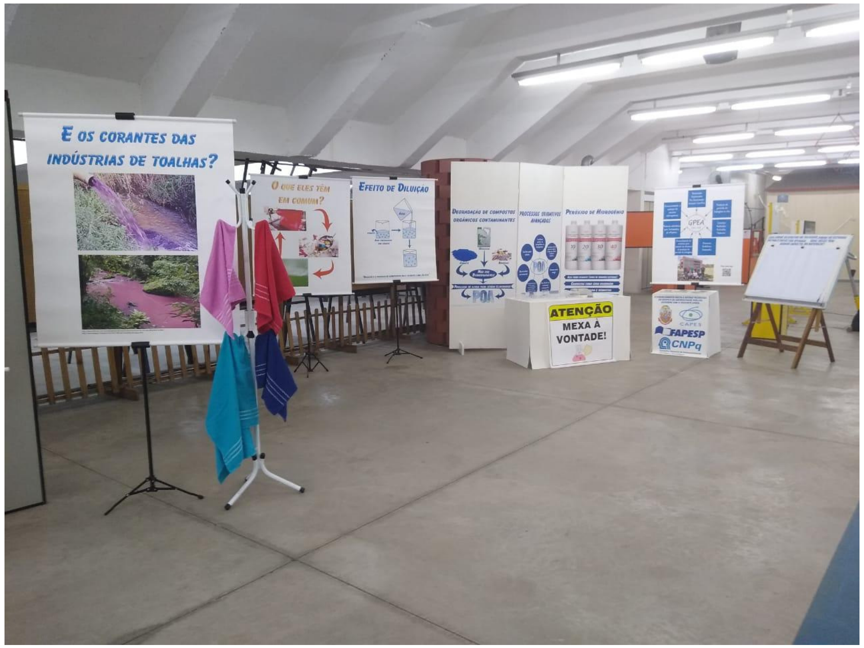


Actually, some chemistry teachers take they students to the museum to use the visitation to introduce the concept of oxirreduction.
In this context, this study aimed to evaluate the contribution of the use of a museum model to the significant learning of high school students.



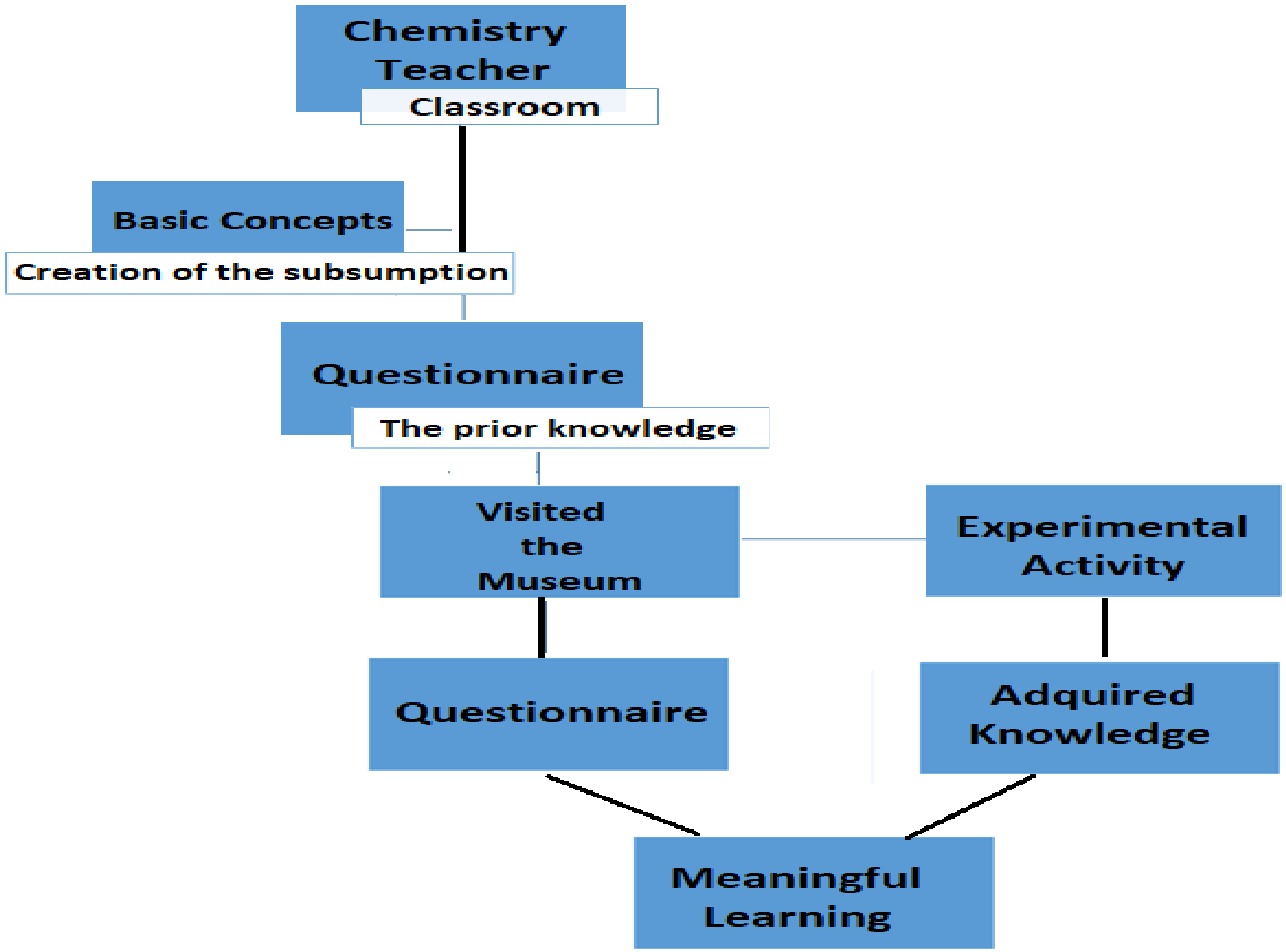
PROCEDURE

The research was carried out at the Science Museum "Professor Mário Tolentino", and had the participation of 26 students (aged 15-17 years, 10 girls and 16 boys) from the second and third year of high school. The school that participated of this research is public, midsized and has elementary and high school, does not have a chemistry laboratory. The chemistry teacher Patrícia was responsible for applying the class on oxirreduction and working on students' prior knowledge.



As a data collection stage, a questionnaire was applied before and after the students' visit to the exhibition and an experimental activity.

Fluxogram: a data collection stages.



RESULTS AND DISCUSSIONS

The Tables 1 and 2 provide examples of student responses to the first question "What do you mean by oxirreduction?".

Table 1: Pre and post visit answers of some students who were able to relate knowledge.

Students	Pre visit	Post visit
A	"It's a chemical reaction in which oxidation or reduction of atoms of substances occurs in that process."	"It's a process where electrons are removed from a particular substance to make it biodegradable."
D	"It's a chemical reaction in which there is oxidation and reduction of atoms of substances present in the process."	"It's a chemical process in which oxidation occurs along with reduction, and can be used to clean water, etc."
E	"It's a chemical phenomenon in which we produce electricity from oxidation and reduction of chemical species."	"It's a chemical reaction that helps in the degradation of materials in the environment."

Table 2: Answers from students who could not relate the knowledge.

Students	Pre visit	Post visit
C	"It's a chemical reaction in which there is oxidation and reduction of atoms of a substance."	"This is when there is electron loss (oxidation) and NOX increase. The reduction is the opposite. "
F	"Oxidation is a chemical reaction in which electron transfer occurs, so either the element reduces (gains electrons, NOX decreases) or it oxidizes (loses electrons, NOX increases)."	"Oxidation is a chemical reaction where electron transfer occurs, so either the element reduces (gains electrons, NOX decreases) or oxidizes (loses electrons, NOX increases)."

It was observed that in the comparison between the answers regarding question 1, pre and post visitation, 54% (14 students) altered the content of the answers, representing that they acquired new knowledge, characterizing significant learning, while 46% (12 students) did not alter their answers, showing that they could not yet relate the themes.

As far as Tavares is concerned [6], when the learner comes across new information, he can decide how his learning will be. If the content is memorized, its learning will be mechanical, because it will only be able to reproduce this content, and there is no understanding of the presented content, as is shown in Table 2, for students C and F.

However if the learner makes connections between this new content presented to him and his prior knowledge in related subjects, he will be building personal meanings for this information, turning it into knowledge, into meanings about the content presented. This construction of meanings is called significant learning, and is possible that happened with students A, D and E.

In Table 1 is possible to notice that they related the content observed in the museum with previously acquired in the classroom and thus they built new meaning for the content in question.

Tables 3 and 4 provide answers to the second question "Do you think oxirreduction can help the environment? Such as?".

Table 3: Pre and post visit answers of some students who related knowledge.

Students	Pre visit	Post visit
A	"Yes. I don't know yet, but I really want to learn. "	"Yes, as it helps to degrade toxic substances released into the wild, making them biodegradable."
B	"I don't know yet, but probably with inventions involving reductions."	"Yes. For example: In the removal of environmentally harmful liquids, such as dye. The model is a good example. "
C	"I don't know, but probably yes."	"Yes. As we saw in the model, the addition of hydrogen peroxide causes the dye particles to transfer electrons, promoting water purification/dye removal. "

IQSC USP NARST A global organization for improving science education through research LINECIN GPEA IQSC / USP

Table 4: Answers from students who could not relate the knowledge.

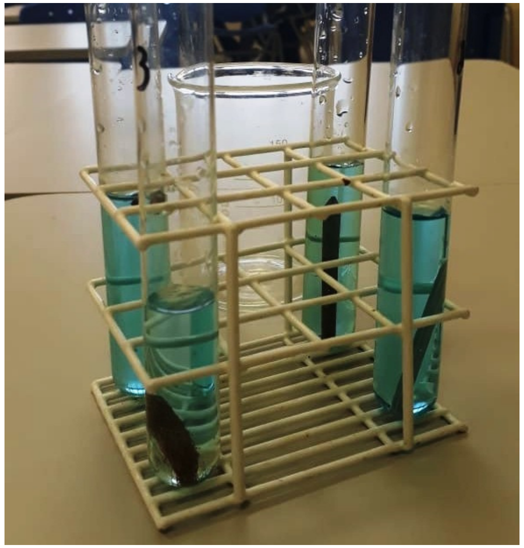
Students	Pre-visit	Post-visit
G	"Yes. I don't know, but I would like to learn. ”	"Yes. We start to have a more curious look. ”
H	"Yes. It makes us look curious.”	“I think so, but I can't explain how.”

For the second question (Tables 3 and 4), it is observed that, in the comparison between the pre and post visitation answers, 85% (22 students) changed the content of their answers, representing that they acquired new knowledge, being characterized as significant learning, while 15% (4 students) had no changes in their answers.

According to Echarri and Puig [7], meaningful learning consists in extending existing knowledge, and thus building new concepts relating to previously acquired knowledge, as occurred with 85% of students (students A, B and C). As can be verified through the answers in Table 3, they were able to relate their previous knowledge with the new contents presented in the exhibition, thus building new concepts.

Already with students G and H (Table 4) this does not occur, which may probably be due to the fact that they could not create the subsunption or not relate the previous knowledge to the new knowledge presented in the exhibition.

In order to reinforce the assimilation of students' new knowledge, a third stage of the activity was performed, where experimentation was used as a support tool for learning.



Thus, after the experiment was proposed to students to develop a hypothesis to explain what had happened in it.

Examples of the hypotheses are shown in Table 5.

Table 5: Students' hypotheses regarding the experiment performed.

Based on your knowledge, make a hypothesis to explain what happened in the experiment.	
Student	**Answer**
B	**"Oxidation of the steel wool occurred reducing its NOX. The brad has not completely oxidized, as it has a protective cover (galvanization). But in both there was corrosion. "**
D	**"When copper sulfate solution comes into contact with both steel wool and brad, oxidation occurs. But for steel wool the reaction is faster than with the brad due to the larger contact surface. "**
I	**"It is observed that the larger the contact surface, the greater the reaction speed."**

It is observed that 46% (12 students) of the students were able to relate the contents seen in the classroom, in the exhibition and the experimentation.

Other 31% (8 students) of the students went further and related the oxirreduction with other previously learned content, factors that influence the speed of reactions.

Finally, 23% (6 students) of the students related the experiment only to the reaction speed content, failing to relate the sequence of activities with the concept presented.

According to Brum and Schuhmacher [11], during the process of meaningful learning, there is a change in both the new information and the subsunption to which the new knowledge relates, and the result of this interaction is the assimilation of meanings. Thus, these results show that most students were able to achieve significant learning of the concept of oxirreduction, since they were able to relate knowledge and assimilate new meanings.

CONCLUSIONS

From the obtained results it was possible to verify the influence of the use of a museal exposition and of a Chemistry experiment in the learning of the concept of oxirreduction of high school students.

It was observed that most students were able to build new knowledge through the relationship with previously acquired knowledge, which is characterized as meaningful learning. A few students, however, failed to realize this relationship, which may be due to the lack of prior knowledge required or the lack of interest and motivation in learning chemistry.

From these results it can be concluded that the influence of the use of a museal exposition to the learning of chemistry was positive, that is, it acts to improve learning making it meaningful.

Through the results presented, it is possible to note the importance of work in relation to learning and that it is essential for students to achieve meaningful learning.

REFERENCES

[1]D.P. Ausubel, The acquisition and retention of knowledge: a Cognitive View ed. Dordrecht: Kluwer Academic, 2000.

[2]H.S. Hsiao, C.S. Chang, C.Y. Lin, Y.Z. Wang, Weather observers: a manipulative augmented reality system for weather simulations at home, in the classroom, and at a museum. Interact Learn Envir 24 (2016) 205-223.

[3]S.D. Coll, R.K. Coll, Using blended learning and out-of-school visits: pedagogies for effective science teaching in the twenty-first century. Res Sci Technol Educ 36 (2018) 185-204.

[4]A.C.D. Steola, A.C. Kasseboehmer, The Space of Chemistry in the Brazilian Science Centers and Museums. Quim Nova 41 (2018) 1072-1082.

[5]A.C.D. Steola, Production of museum model to promote an Institute research of Chemistry of São Carlos and evaluation of the motivation for learning in Sciences., in, Instituto de Química de São Carlos. , Universidade de São Paulo., São Carlos, 2019, pp. p.101.

[6]R. Tavares, Meaningful learning and teaching of science. Ciências & Cognição 13 (2008) 94-100.

[7]F.P. Echarri, J., Environmental Education and Meaningful Learning: Didactic Applications in the Natural Sciences Museum of the University of Navarra. Inted2016: 10th International Technology, Education and Development Conference (2016) 7079-7087.

[8]W.P. Brum, Schuhmacher, E. , Meaningful Learning: theoretical review and presentation of an instrument for classroom application. Revista Eletrônica de Ciências da Educação. 14 (2015) 20.

THANKS

Grant #2018/20145-7, São Paulo Research Foundation (FAPESP), Grant # 2017/10118-0, São Paulo Research Foundation (FAPESP), Grant # 2019/04543-5, São Paulo Research Foundation (FAPESP), CNPq and CAPES for their financial support. To the "Professor Mário Tolentino" Science Museum, the students and the teacher of André Donatoni State School.